

**VOLCANIC ROCKS AND THE GEOLOGIC HISTORY OF MARS.** P. A. Salpas, Dept. of Geology, 210 Petrie Hall, Auburn Univ., AL 36849

A number of questions exist regarding the geology of Mars which can be addressed by the proposed Mars rover-sample return mission. These include: (1) The planet's bulk composition and chemical differentiation during formation of its core and crust. (2) The extent to which internal geologic activity continues. (3) The evolution of its atmosphere. (4) The extent and duration of fluvial processes and an accounting of Mars' volatile inventory. (5) The extent to which eolian processes are presently reshaping the surface. (6) Is there, or was there, life on Mars?

The use of a rover during the proposed mission greatly enhances the ability to investigate multiple aspects of Mars' geology and geologic history. However, the physical constraints imposed by the mobility of the rover and by the amount of sample which can be carried by it and the return vehicle may make it necessary to narrow the number of questions which can be addressed directly. Attempting to address all of the important questions may dilute the amount of information that can be obtained regarding each question and may result in no satisfactory answers. Prioritization is essential for a successful mission.

The task of setting priorities is simplified somewhat when it is considered that answers to some of these questions do not require taking samples, and that for some questions, sample location is not as important as for others. Atmospheric, weathering, sedimentary transport, and seismic studies can be conducted at most locations planet-wide, and some topics (e.g., fluvial and eolian processes, volatile inventory, surface composition) can be addressed partially by the orbiting vehicle. The choice of sampling locations will be dictated largely by those questions which, in whole or in part, require specific sites. Among these are: (1) The question of life on Mars. If life has ever existed on Mars the evidence would be found in those regions most conducive to life - i.e., wet, warm and sheltered from harmful solar radiation. (2) The volatile inventory question - do large amounts of water exist subsurface as permafrost [e.g., 1,2]? (3) The geochemical evolution of Mars. Sampling traverses through a volcanic region that possesses a diversity of rock types and ages could provide a wealth of information regarding the compositional evolution of the planet. However, such traverses would probably exclude investigations of questions (1) and (2) as the water which is sought after is most likely to be found in regions of thick regolith. Without diminishing the importance of other geologic questions, the remainder of this abstract will address Martian volcanic rocks.

It is thought that the ages of volcanic rocks on the surface of Mars range from the time of a major resurfacing event, about 3.5 to 4.0 Gy [3,4], to the relatively young rocks of Olympus Mons, about 0.2 Gy [5]. These ages are in contrast to those of Moon which are mainly ancient, derived from a major differentiation event around 4.5 Gy and a period of volcanism which ended about 1 Gy later. Unlike Earth whose rocks are relatively young,

the surface of Mars has not been extensively ravaged by either a highly active atmosphere or (to the best of our knowledge) plate tectonics. The volcanic rocks of Mars will therefore contain information about processes which are "intermediate" during the compositional evolution of the terrestrial planets.

The surface of Mars presents two distinct terrains, both of which have the potential to contain valuable information regarding the composition of Mars. One terrain, comprising mainly the southern hemisphere, is ancient and heavily cratered and is the more likely of the two to provide a suite of rocks which include ancient crustal samples. However, these samples will be locked up within breccias, and we can anticipate from our experience with lunar breccias the problems of interpretation which will ensue (e.g., pristine vs. non-pristine, lack of field control). Furthermore, the ages of the ancient Martian rocks from this terrain probably do not exceed 3.5 - 4.0 Gy and therefore do not represent primordial crust such as found on Moon [3].

The other terrain, mainly in the northern hemisphere, is not heavily cratered, and contains extensive volcanic fields. Samples collected here could possess a wide range in age and afford excellent documentation of the differentiation of Mars' interior by providing samples which range from mafic [6] to felsic [7] in composition ([8] questions the evidence for silicic volcanism on Mars). A prime location for sampling is the Tharsis Plateau. This broad region of uplift straddles the boundary between the ancient, heavily cratered terrain in the south and the younger plains in the north. It has been postulated that the ages of volcanic rocks in the cratered plains of Tharsis may be as great as 3.8-4.0 Gy [4]. Young volcanic material is also to be found on Tharsis; the youngest rocks on Olympus Mons are estimated to be only 0.2 Gy [5]. The morphologies of most lava flows on Tharsis are suggestive of mafic compositions [6] but the ignimbrite province of [9] offers the possibility of finding compositionally evolved volcanic rocks on the plateau.

Sampling the rocks of the Tharsis Plateau to maximize the diversity of samples is probably impractical. To put the matter into perspective, the map distance of the cratered plains in southern Tharsis to the summit of Olympus Mons is about 4000 km. However, the Tharsis region offers the opportunity to select from volcanic rocks which span nearly the entire geologic history of Mars and document the chemical differentiation of the planet. Choice of this site might rule out visits to other geologically interesting locations.

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